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Unturned Furrows

The venerable plow is steadily yielding ground to a more modern way of farming: minimum tillage and related methods. Indeed, a USDA study predicts that by the year 2010, American farmers will practice conventional tillage methods on only 5 percent of our cropland. Many names have been coined to describe local variations of minimum tillage, including wheel-track planting, zero tillage, crop-residue planting, and slot planting, among others. By whatever name, this modern method of planting enables farmers to obtain good crop yields while providing a complete soil cover that retains moisture and prevents erosion.

Minimum tillage gained its initial impetus after World War II as farmers began feeling the pinch of chronic labor shortages. Anxious to complete planting on time, enterprising farmers began learning how to save time and labor by planting row crops in narrow strips of soil cut open by a coulter blade or chisel; the narrow seedbed was then compacted by the tractor's wheels. Variations and refinements have come with the passing years. Today's minimum tillage farmer plants a winter cover crop, typically rye, after the fall harvest. In the spring, he kills the rye with herbicides, then seeds the main crop into the resultant mulch with a special planter. Not a furrow is turned, nor does the farmer need to reenter the field until harvest time, when he begins the cycle anew.

Plowless farming is now underway on more than 6 million acres in this country, and expanding rapidly. Minimum tillage methods are not without their problems, however. Insects once held in check by deep plowing tend to thrive in undisturbed soil and mulch. Farmers who fail to anticipate this problem and to select the proper insecticides, court disaster. Furthermore, herbicide applications must be made on a precisely timed basis to establish enough mulch to check erosion, yet not smother the seedlings.

Science will help remedy these and other problems related to minimum tillage farming, a concept recently cited as a "truly basic change in the history of our agriculture." Minimum tillage unquestionably saves farmers time, labor, and money. Its long-term benefits, however, may well lie not in farm economics but in conservation. For the unturned soil, protected by its layer of mulch, can retain 50 percent more soil moisture than a plowed field, and cut erosion and runoff on sloping fields by up to 90 percent. This is good news in these times of environmental awareness and consequent social constraints. Not only can minimum tillage help save a life-sustaining resource—it can also greatly abate the critical problem of pollution and siltation of our waterways. It is an idea whose time has come.—*R.P.K.*

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COVER: From waste to resource. Sewage sludge mixed with woodchips is composted for fertilizer and mulch on a 15-acre test site at the Beltsville Agricultural Research Center (1175X2226-25). Article begins on page 7.

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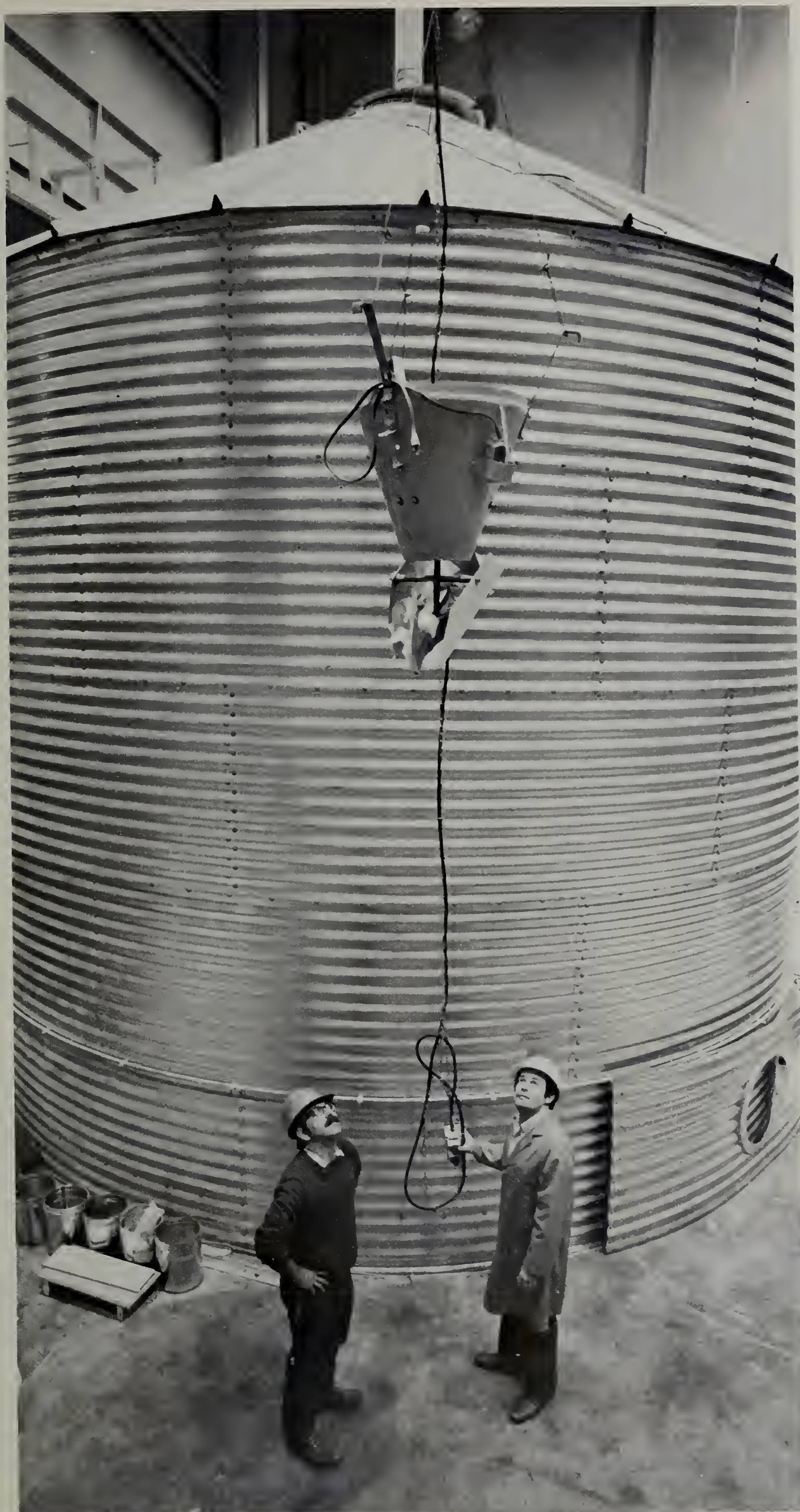


In preparation for tests conducted in the pilot plant of the U.S. Grain Marketing Research Center in Manhattan, Kans., research technician Larry E. Shakleford and Dr. Stephens hoist a grain spreader into place atop a storage bin. Grain spreaders distribute fine material—dust and broken grain—evenly throughout the bin, thus increasing total bulk density and volume (1175X2273-26).

Grain Spreaders: Pros & Cons

MECHANICAL grain spreaders used to fill grain bins are useful tools, but not without disadvantages.

The advantages are impressive, says ARS agricultural engineer Lyle E. Stephens. Nine bushels of shelled corn can be stored in the space that would be occupied by eight if the bin is filled through a vertical spout. And no hand labor is needed for leveling the grain after filling.

On the other hand, aeration to pre-

Grain Spreaders:

After the spreader is secured, Mr. Shakleford tapes the seam between the spreader and the grain spout to reduce dust leakage (1175X2274-4).

vent deterioration of grain in storage is more costly, Dr. Stephens says. With more grain per unit of volume—greater bulk density—resistance to airflow is greater. So aeration time increases, with corresponding rise in power cost, or there is greater risk of damage by molds and insects with inadequate aeration.

Mechanical spreaders distribute the grain over the entire grain surface of the bin for uniform filling. In contrast, the spout deposits all of the grain in the center of the bin, and fine material (broken kernels and dust) forms a core under the spout. With a spreader, fine material is rather uniformly deposited between the kernels, throughout the bin, filling spaces between kernels. This explains why bulk density is greater, Dr. Stephens says.

He and agricultural engineer George H. Foster evaluated three commercial grain spreaders at the U.S. Grain Marketing Research Center, Manhattan, Kans. They filled bins to about 5- to 10-foot depths with shelled corn initially containing less than 6 percent fine material. The corn had been dried with natural or heated air.

They found that when filling with a vertical spout, the grain under the spout contained 11.6 to 24.8 percent fine material, with only 1.7 to 3.3 percent at sampling points near bin walls. With mechanical spreaders, the grain under the spout contained 3.8 to 10.3 percent fine material and 1.2 to 3.3 percent near bin walls.

Bulk density of stored corn increased 12.5 to 19.9 percent, depending on the type of mechanical spreader used. Compaction during spout filling increased initial bulk density an average of 3.7 percent.

Dr. Stephens notes that resistance to

airflow was 1.6 to 2.9 times greater when bins were filled with grain spreaders instead of a vertical spout.

Research is underway at Manhattan to develop a more effective alternative to the vertical spout for filling grain bins. The high-density core of fine material it deposits in the center of the bin increases time and cost of aeration or drying, with the alternate risks of deterioration or overdrying the remainder of the grain. When the bin is unloaded at the bottom, under the spout, a third to half of the grain may be lowered in grade because of excessive fine material, and the higher grade of the remainder may not offset the loss.

Dr. Stephens points out that grain for export may be handled 12 to 20 times, with a gradual increase in the amount of broken kernels with each handling. ☐

Far left: Mr. Shakleford takes a sample from one of the 31 test locations inside the storage bin. A segmented grain probe is used so that samples can be taken at various depths (1175X2275–3).

Left: Collected samples are screened to determine the distribution of fine material. The even distribution achieved through the use of mechanical spreaders reduces the amount of air pressure needed to air-dry grain by up to three times (1175X2275–32).

The Arkansas Strain

Twenty years ago, unusual-appearing weevils in stored corn on an Arkansas farm attracted the attention of ARS entomologist Hobart P. Boles. They were larger and darker than typical rice weevils and, unlike them, proved difficult to rear on wheat in the laboratory.

Those weevils were the parents of what is now known as the Arkansas strain of the maize weevil. This strain has since been used in more than 20 studies, which established the economic importance of the maize weevil in this country and otherwise contributed to more effective control of insects in stored grain.

Dr. Boles, now at the U.S. Grain Marketing Research Center, Manhattan, Kans., points out that progress toward safer and more effective ways of restricting insect damage would be difficult and slow without laboratory strains such as this one. They are readily available any time of the year, in egg, larval, pupal, or adult stage of development. More important, their biological characteristics are known.

An entomologist could collect insects from their natural habitat as needed. Not only is this inconvenient, but such insects may have been exposed to pesticides or diseases, modified by mutation, or be a different strain from what was used in related studies.

The Arkansas strain of the maize weevil has been maintained since 1957 by Kansas State University entomologists.

It was an essential research tool in 1 study on life history, 6 on species identification, 3 on response to environment, and 12 on resistance to damage in sorghum, rice, wheat, corn, and soybeans. ☐

Toward More Nutritious Wheat

Wheat breeders can probably increase wheat's nutritive value in a way that puts more protein in the endosperm, the part of the wheat grain that goes into white flour.

In Atlas 66 and Nap Hal wheat varieties different parts of the kernel vary in their protein content, ARS agronomists Kenneth P. Vogel and Virgil A. Johnson and agronomist Paul J. Mattern of the Nebraska Agricultural Experiment Station, Lincoln, found.

High protein in grain of the Atlas 66 variety is in the endosperm, while that of the Nap Hal variety is in both endosperm and bran. Bran is usually fed to livestock. Analysis of whole kernels had earlier identified Atlas 66 as a high protein source, and Nap Hal as a source of increased protein and lysine.

The high grain lysine content of Nap Hal is largely a result of the high protein content of its bran, the agronomists found. Increasing the amount of lysine, a component of protein in shortest supply in wheat, would also increase the nutritive value of wheat products.

The studies also indicated that the genes for endosperm protein of Nap Hal are different from those of Atlas 66, Dr. Vogel says. Crosses between the two produced some plants with as much as 23 percent endosperm protein when the parents had only 19 percent. Separate genes apparently joined in raising the protein content of some offspring above that of either parent. ☐

A New Era for Dairymen

People worry about computers depersonalizing their lives, but on dairy farms the advent of such modern management tools could mean a new era of freedom. And dairy cattle may still receive plenty of tender loving care.

Dairy herdsmen may find contentment in taking vacations, knowing that a fellow worker will give the attention milk cows deserve.

That's the hope and conviction of ARS agricultural engineer Hoyle B. Puckett, who is developing dairy mechanization in cooperation with the Illinois Agricultural Experiment Station, Urbana.

Obviously, when Mr. Puckett talks about leisure time and computers for dairy herdsmen he is thinking about bigger operations than exist on most dairy farms today. He sees no way for farmers to turn back the clock for the "idyllic" days of sustenance farming. Mechanization in food production must continue to progress, he says, especially as the Nation looks toward expanding world markets.

While the Nation's milk production has already become well mechanized, it still typically requires high labor input—0.7 man-hour for each hundred pounds of milk or about 23 percent of production expense.

Despite continuing development of labor-saving devices, Mr. Puckett says dairying will likely remain as one of agriculture's labor-intensive enterprises. But as new mechanized management concepts develop, dairy farmers may expand their operations to include more cows and mold large labor forces to care for the cows responsibly.

Still, of crucial importance to dairying success is the individual herdsman's attention to individual cows, Mr. Puckett says. In most mechanized milking systems today, 1 herdsman can effectively handle 50 to 60 cows.

Some manual jobs still exist that are best left unmechanized. The jobs are of short duration and require individual treatment for each cow—washing teats and attaching teat cups.

While a herdsman performs these routine manual tasks, Mr. Puckett observes, he becomes familiar with individual cows and learns to exercise judgment before serious problems develop. He relies on more than cows' records to assure himself of their well-being. He must ask himself, "When does a cow require medical treatment or other services?"

If the number of cows he cares for becomes quite large, his memory about each cow becomes overloaded and his attention wanes. The results—missed breeding periods, high incidences of mastitis or other dieases, and poor milk production.

The solution for maintaining efficient production while increasing herd size, Mr. Puckett suggests, is "management by exception." A management tool, such as a computer, could complement the empathy a herdsman has for his cows and help him remember details—a necessity for doing a good job.

As computers help make large-scale operations economically feasible, they may also help herdsmen arrange for times of rest and relaxation, improving mental outlooks.

To illustrate, Mr. Puckett considers a computerized operation with some 3,600 cows. Using currently available labor-saving technology, 47 workers would be required. In an operation this size, he calculates, dairy herdsmen, like their city cousins, could work 8 hours per day, 5 days per week, and have 2 weeks' sick leave and 2 weeks' vacation per year.

Setting up a large, efficient milk production system cannot be done, however, just by installing a computer in the milking parlor and increasing herd size by 60 times, Mr. Puckett says. First, sets of favorable conditions for high productivity must be mathematically defined as computer "models." These models would allow the computer to make routine value judgments and help herdsmen flag cows that differ from norms. Then critical evaluations could be made.

Conditions that one day may be monitored through a computer, Mr. Puckett says, may include body temperature, body weight, and feed consumption. One could expect variations in cows' physiological conditions to be caused by estrous cycles, mastitis infection, general body infections, and inadequate diets. Each cow may differ from her herdmates because of her individuality.

As the cows build their records into the system, predictions of performance should become increasingly accurate, and deviations from the norms would indicate to the herdsman the matters that require his attention.

Each cow's performance could then be measured against her own records, Mr. Puckett says, and she could be considered as a unique individual in her technological world. □

High above Frostburg, Md., orchard grass and clover grow lushly on what was once an unsightly, acid-leaching, and sediment-producing strip-mine spoil. Composted sludge was applied to the highly acid soil at rates of 25, 50, and 100 tons per acre. Three months after seeding, the spoil was fully vegetated—despite an original pH of 2.9. Microbiologist George Griebel, agronomist Walter Armiger, and Maryland strip-mine forester Frederick Bagley collect forage samples to be analyzed for heavy metal content. ARS and Maryland scientists are cooperating in this research project (0775X1122–28A).

Compost: From waste to resource

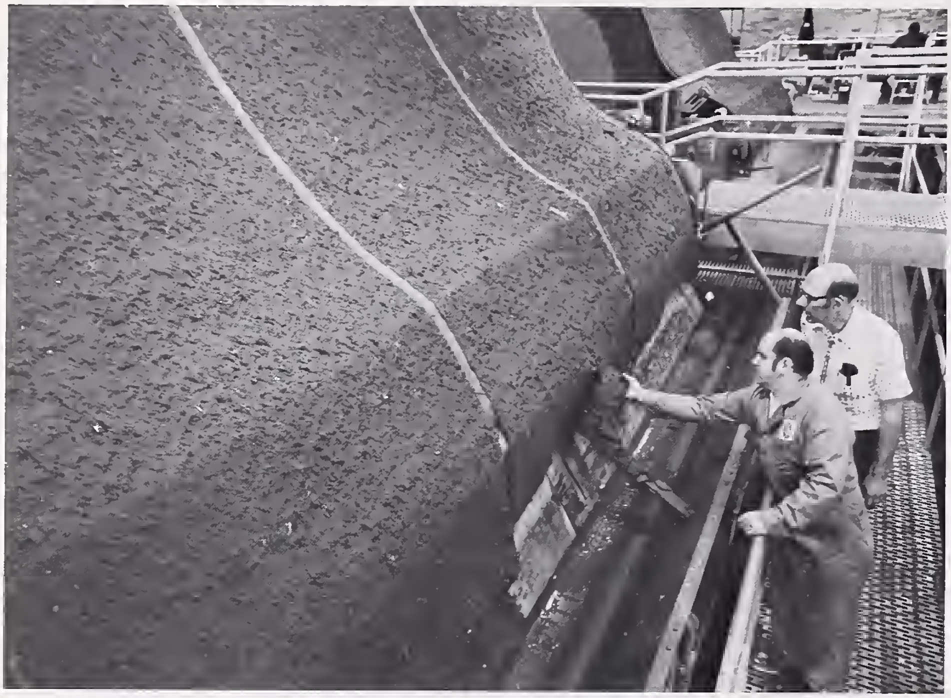
NEW APPLICATIONS of an old principle—composting of sewage sludge—score an E for excellence in preliminary tests for efficacy, economy, environmental soundness, and esthetic quality.

Composting once was considered out of the question as a solution for the pressing needs for better waste disposal methods. However, research is answering many questions about the practicality of composting, including two crucial points: Can this age-old principle be modified to operate successfully on an urban scale? Can composting be conducted during cold, wet weather typical of most American cities for several weeks or months of the year?

An experimental forced aeration system and related technology developed by soil scientist Eliot Epstein, agricultural engineer George B. Willson, and their associates at Beltsville, Md., demonstrate the practicality of composting on both an urban scale and under a wide range of climatic conditions.

Furthermore, the Beltsville system operates at a cost of only about $20

Compost:



Sludge destined for composting rolls off the vacuum filters at the Blue Plains wastewater treatment plant near Washington, D.C. Agricultural engineer George B. Willson observes as shift supervisor Ed Bobick checks consistency of the sludge. Samples are taken daily and analyzed for acidity, chemical content, and bacteria in compliance with local, State, and Federal laws (1175X2224–20A).

to $50 per dry ton of sewage sludge. In contrast, incineration costs an estimated $100 to $150 per dry ton and wastes valuable resources.

The Beltsville system, designed and tested in cooperation with the Maryland Environmental Service, handles 50 tons of filter cake sludge (23 percent solids) daily—a rate capable of serving a city of 200,000 to 400,000 people.

Outdoor temperatures as low as 20° F and rain totaling 7 inches per week failed to interfere with the experimental composting system.

Even lower temperatures and higher precipitation will be tested in cooperation with the city of Bangor, Maine, and the Environmental Protection Agency. Part of this work will be conducted at the New England Plant, Soil and Water Laboratory, Orono, Maine, by ARS soil scientist Walter J. Grant.

Both the Bangor and Beltsville proj-

Leaf samples from soybeans and corn fertilized with composted sludge are taken by technician Timothy W. Palmer and Elizabeth N. Spear. The leaf samples will be analyzed for water, nitrogen, and heavy metals content to help scientists better understand the fertilizer value of composted sludge (0775X1124–8).

Compost:

ɔcts employ the same experimental approach. Sludge from the Blue Plains primary and secondary treatment plant, Washington, D.C., and sludge from Bangor's primary treatment plant, undergoes a 7-week composting process that reduces each 50-ton input :o 20 tons of agriculturally valuable compost.

Woodchips or bark are mixed with :he sludge at a 3:1 ratio. The mixture is then piled to a height of 8 feet over a 12-inch base of woodchips. Under :he base lies 70 feet of 4-inch-diameter perforated pipe for use in aeration. The sludge-chip mixture forms a pile 10 by 20 feet. Capping the pile is a 12-inch layer of finished compost that ɿas been screened to remove the woodchips. This top layer extends down the sides to filter out malodorous gases that might escape into the atmosphere.

Air is pulled through the pile by a

Laboratory technician Alan H. Hart uses a diffusion porometer to measure water uptake of grasses and soybeans fertilized with composted sludge of varying rates of application. Scales measure water loss from both soils and plants. These test results will enable scientists to determine the proper amounts of composted sludge for fertilizing various crops (0775X1123–28).

Bangor, Maine, is one of the Nation's first municipalities to have its own sewage sludge composting capability. With matching Federal funds and technical assistance, Bangor has created a system that composts all of the city's weekly sludge output of 50 cubic yards and waste bark from local pulp and paper mills. Using a heat-sensing probe, Dr. Epstein demonstrates to Bangor and Federal officals how high temperatures generated by bacteria cause the decomposition of organic matter in compost piles. With Dr. Epstein are Larry Prior, Envionmental Protection Agency, John Flynn, assistant city manage, John Joseph, Bangor assistant public works director, Ralph Nischow, superintendent of Bangor's wastewater treatment plant, and Ralph Hamel, composting project foreman (1075X2113–24).

0.33-horsepower blower connected to the pipes under the pile. The blower operates automatically at various intervals, depending upon the temperature. Airflow through the blower inlet is about 200 cubic feet per minute, which is sufficient to provide a 5- to 15-percent oxygen concentration throughout the pile.

Bacteria responsible for the composting process are stimulated by the oxygen concentration and airflow to complete the process within 3 weeks. Temperatures produced are above 140° F in the pile, and often exceed 175° F, for the entire process.

Such temperatures, combined with time, are sufficient to kill disease agents such as viruses, bacteria, protozoan cysts, and eggs of intestinal worms. ARS microbiologist Wylie D. Burge and his staff are working to determine the efficiency of the composting process in detroying these disease agents.

The aeration system also acts to draw gases from the pile, deodorizing them as they pass through a pile of screened compost at the pipe outlet. Obnoxious odors did not occur during these experiments.

After 3 weeks, the compost is moved to a stockpile for curing for 4 weeks. Then it is screened and the woodchips or other bulking agent recovered for reuse.

The compost, almost as light as sawdust, is an odorless, esthetically attractive material suitable for use on crops, lawns, potted plants, and other ornamentals.

Analyses of the compost by ARS plant physiologist Rufus L. Chaney showed nontoxic concentrations of heavy metals.

Further tests are needed to determine if cities that are more industrialized than Washington, D.C., might produce compost of a suitably low metal content for land application.

Compost nutrients useful for plant growth are principally nitrogen (1.6 percent), phosphorus (1 percent), and potassium (0.16 percent). The nitrogen is mostly in an organic form and thus is released slowly. Up to 20 dry tons of compost per acre can be applied to the soil without overfertilizing plants or releasing nitrates into the ground water.

The biggest benefit from composting is its value as a much-needed soil conditioner. Compost significantly increases the water-holding capacity of soils, reducing the need to water lawns or crops. Sandy and clay soils are particularly improved by the compost.

Promising uses under test include applications on corn, soybeans, vegetables, sod, and nursery plants. □

Microbiologist Nancy K. Enkiri analyzes compost samples for fecal coliform and salmonella to insure that composting has destroyed such pathogens (0775X1125-17A).

Compost:

Groundsman Dave Voinche rakes Beltsville sewage sludge composted into tourist-worn lawn surrounding Maryland's State capitol at Annapolis. Maryland, through a cooperative agreement with USDA, is using sludge compost to repair lawns and to provide a mulch-fertilizer for trees and bushes around State buildings and in parks (1175X2265–21A).

Huge machines windrow and aereate sludge and woodchips at USDA's test site in Beltsville. Scientists are experimenting with digested and undigested municipal sewage sludge of varying wood-to-sludge ratios. They foresee applying the technique across the country using sludge and locally available composting materials such as paper waste products, wood bark, cotton gin trash, and begasse from sugar cane processing (1175X2227–27A).

During the last 2 years, commercial apple wholesalers have enthusiastically adopted controlled atmosphere storage techniques developed by ARS scientists. CA rooms like this one can store up to 40,000 bushels of apples (1075X2095–19A).

Quality that lasts

Dr. Olsen prepares a controlled atmosphere chamber for testing Golden Delicious apples in a high concentration of CO_2. ARS researchers are trying to determine what causes CO_2 sensitivity in some apples while others from the same orchard are insensitive to the same conditions (1075X2097–15).

About 20 percent of this year's Golden Delicious apple crop went to market late, but despite the lateness in season, displayed unusually high quality and exceptional firmness. Such a previously unheard of achievement is the result of a special treatment developed by ARS researchers.

Treating Golden Delicious apples with specific levels of carbon dioxide over a specific number of days improves fruit firmness, texture, and storage life. The technique promises to be a great aid in marketing the apples and maintaining a reasonable price over a longer marketing season.

Climatic conditions enable Washington State to produce a high quality Golden Delicious apple. Golden production in Washington increased from 2 million boxes 10 years ago to over 13 million boxes last year. This rapid increase placed a great strain on packing, storage, and marketing facilities. Substantial improvements in apple handling techniques were needed.

The carbon dioxide treatment developed by ARS plant physiologists Kenneth L. Olsen and H. Melvin Couey, Wenatchee, Wash., permits rapid harvest and placement of Goldens in loose bin storage, and holds the fruit in excellent condition for packing later in the season.

Fruit packed in March and April and even in early May following carbon dioxide treatment retains a fresh and crisp texture until early July with little bruising caused by the late packing operation. Goldens, generally harvested in September, lose their firmness by January with current handling techniques.

In the ARS treatment, mature Goldens are exposed to a 15- to 18-percent carbon dioxide atmosphere in

a closed storage room for a 10-day period. The 10 days begin when storage room atmosphere reaches 10 percent carbon dioxide. Care must be taken not to allow the carbon dioxide atmosphere to exceed 20 percent or else the fruit will suffer internal damage.

It is also crucial that apples be harvested at the proper state of maturity. Immature apples are susceptible to surface injury by carbon dioxide and treatment effects are reduced when the fruit is too mature. A filled-out, smooth calyx end and breaking color, going from green to yellow or white, indicate proper apple maturity.

At the end of 10 days, the carbon dioxide is flushed from the storage room and the Goldens are held in a standardized controlled-atmosphere storage unit.

A controlled-atmosphere for storing Golden Delicious apples in the Pacific Northwest contains 2 to 3 percent oxygen and not over 2 percent carbon dioxide at 30° to 32° F.

ARS recently tested this technique on 36,000 bins of Golden Delicious apples (more than 900,000 boxes) at 21 different warehouses in central Washington.

Treated apples were approximately 2½ pounds firmer than untreated apples taken from the same orchards at the same time.

Firmness was measured as the amount of force needed to press a 7/16-inch-diameter plunger 5/16 inch into the fruit's skinless flesh. Fruit quality was also good. Less than one-half of 1 percent of all apples treated showed any injury from the treatment.

The successful treatment tests resulted in some of the highest quality and most firm Golden Delicious apples ever marketed in the April through July period.

During the next season, researchers plan to conduct additional testing of individual orchards to identify any characteristics that might preclude using the treatment on a particular apple lot. □

The Perfluidone Response

Answers to important questions were still needed after perfluidone was identified as a promising herbicide for controlling yellow nutsedge in cotton.

How does perfluidone kill this difficult-to-control weed? How does the herbicide affect the cotton? Are the effects on cotton temporary or permanent? Would its use be hazardous to the environment or harm succeeding crops?

These questions have been partially answered by ARS plant physiologist David G. Davis and technician Kendall E. Dusbabek at the Metabolism and Radiation Research Laboratory, Fargo, N. Dak.

They found that perfluidone retards growth of both yellow nutsedge and cotton. The damage is irreversible on nutsedge, but cotton resumes apparently normal growth when no longer exposed to the herbicide. Dr. Davis says nutsedge seems to lack one or more of the capabilities that cotton has for diluting concentration of the herbicide, resisting low levels of perfluidone, or converting it into innocuous compounds.

Nutsedge has been called the world's No. 1 weed. In this country, yellow nutsedge is found in all States except Alaska and North Dakota. Purple nutsedge is a problem weed in parts of the Southeast and Southwest. Both weeds are difficult for farmers to control because their seed, rhizomes, and tubers remain viable in the soil for years and produce new infestations whenever normal tillage brings them near the surface.

ARS plant physiologist Walter A. Gentner, Beltsville, Md., earlier found that low application rates—2 to 2.5 pounds per acre—of perfluidone gave satisfactory control of nutsedge in crops (AGR. RES., Aug. 1971, p. 5). Dr. Davis and Mr. Dusbabek then investigated the reasons for its selective action.

They found that exposure to perfluidone decreased cell division in both yellow nutsedge and cotton, stunted roots and shoots, and caused sloughing off of root cap cells. In both plants, uptake of perfluidone labeled with carbon-14 was slow but increased with time, and most of the labeled herbicide remained in or on the roots.

Perfluidone (or its metabolites) was translocated differently by the two plant species, Dr. Davis says. It was uniformly distributed in cotton shoots but was concentrated in leaf tips of nutsedge. He suggests that the different translocation patterns may relate to differences in growth after prefluidone was removed.

Damage to roots was also more severe in nutsedge. Dr. Davis says the structure of root tips was markedly altered in nutsedge but not greatly changed in cotton. A small amount of cell division also took place in roots of treated cotton but almost none in nutsedge.

The most readily observed difference—many necrotic spots on older leaves of cotton but none on yellow nutsedge—appeared to be unrelated to ability of the two species to tolerate the herbicide. □

Aphids transmit soybean mosaic

Two aphid species, for the first time, have been identified in field studies as transmitters of soybean mosaic, a virus disease that causes mottling of soybean seed and sometimes stunts soybean plants.

The aphids are *Rhopalosiaphum maidis*, or corn leaf aphid, and *Dactynotus ambrosiae*, or brown ambrosia aphid. They live on other plants and occasionally probe or feed upon soybean plants, spreading the soybean mosaic virus (SMV), says ARS plant pathologist T. Scott Abney, who conducted the studies in cooperation with the Purdue Agricultural Experiment Station, West Lafayette, Ind. Corn leaf aphids often harbor in volunteer stands of corn in soybeans. The researchers also found them prevalent in barnyard grass and sorghum, and *D. ambrosiae* colonized both giant ragweeds and cockleburs.

Nine nonaphid species of insects commonly found on soybeans did not transmit SMV in the field study. Two aphids, which other scientists had previously identified as vectors of SMV in greenhouse studies, also transmitted the virus in the field study. These aphids, *Myzus persicae*, or green peach aphid, and *Macrosiphum euphorbiae* or potato aphid, are among 16 aphids that have transmitted SMV in greenhouse studies.

The scientists found potato aphids and green peach aphids both among red root pigweed and ivy leaf morning glory. Potato aphids harbored among six other weed species as well.

Soybean mosaic virus is introduced in Midwest soybean production through the use of virus-infected seed, says Dr. Abney. Then, aphids that colonize weeds in and around soybean fields are responsible for spread of SMV from the virus-infected soybeans to healthy soybeans.

Dr. Abney's study on SMV transmission by aphids will be useful as he conducts further research on improving seed quality of soybeans by controlling diseases. He is screening soybean plant introductions for resistance to SMV and also evaluating resistance in soybean breeding lines developed by researchers throughout the North Central States.

Scientists who worked with Dr. Abney in the soybean mosaic virus-aphid study were Purdue entomologists John O. Sillings and Delmar B. Broersma and ARS agronomists Thomas L. Richards. ☐

Two approaches toward boosting soybean yields

Increasing photosynthesis of soybean plants, and developing cultural systems that encourage efficient use of nitrogen, may be just the approaches needed to attain increased soybean yields.

Probing the life processes in soybeans, ARS plant physiologist James E. Harper and his colleagues at the Illinois Agricultural Experiment Station, Urbana, enhanced photosynthesis by tripling the concentration of carbon dioxide around plants growing in hydroponic systems.

The technique stimulated dry matter production and symbiotic nitrogen fixation and increased total plant nitrogen in nodulated soybeans that were supplied with low levels of nitrate fertilizer. Carbon dioxide enrichment also increased dry matter and plant nitrogen in nonnodulated soybeans when they were supplied with high nitrate levels.

Dr. Harper's earlier research has shown that nitrogen fixation reaches a peak when nitrogen is most needed—during the pod-filling stage—and at the same time, nitrate use declines. Both nitrate utilization and symbiotic nitrogen fixation seem essential for economically obtaining yields in the 60-to-70-bushel-per-acre range. The researcher also found that nitrogen fixation supplies less than half of the nitrogen needed for high yields, yet nitrate fertilization inhibits the symbiotic process which is vital at pod-filling time.

The solution to the dilemma may lie in using some kind of nitrogen fertilizer that is not in nitrate form. Urea is an alternative nitrogen source that does not inhibit the nodulation process in a hydroponic culture, Dr. Harper says. In the soil, however, bacterial strains exist which convert urea and other forms of nitrogen fertilizer into nitrates in a process called nitrification and nodulation is inhibited.

Dr. Harper is now studying use of nitrifying inhibitors with urea fertilizer for soybeans in an attempt to supply additional nitrogen to the soybean plant without decreasing the symbiotic fixation of atmospheric nitrogen. ☐

AGRISEARCH NOTES

Now—Fewer Test Bakings

A 50-PERCENT REDUCTION in number of test bakings per sample has increased the number of winter wheat breeding lines that ARS can evaluate for bread-making quality—or has freed scientists for other baking studies.

A modification in the testing formula by food technologist Merle D. Shogren and chemist Karl F. Finney cut the three to seven loaves baked per sample to no more than two or three. The grain quality and end-use properties unit at the U.S. Grain Marketing Research Center, Manhattan, Kans., evaluates around 2,000 breeders' and other research samples each year.

The bake test is an analytical tool for measuring such baking qualities as mixing requirement, water absorption, oxidation requirement, and loaf volume. The test is an optimized system, Mr. Shogren explains, in which ingredients and mixing time are optimized to let the flour from each sample demonstrate its full potential for producing high-quality bread.

One ingredient in the formula is the oxidant, potassium bromate, which facilitates gas retention and oven spring. With the fermentation time uniform in bake tests, Mr. Shogren formerly determined potassium bromate requirement after baking at 2 to 3 bromate levels to find the optimum level for largest loaf volume and best crumb grain. Now he uses a fixed amount of oxidant in all tests—80 parts per million (ppm) ascorbic acid plus 10 ppm potassium bromate. Occasionally a variety of wheat with a short to medium mixing time may require 20 ppm of bromate, and a variety with a long mixing time may require no bromate; either becomes obvious after the first bake.

Ascorbic acid, like potassium bromate, acts as an oxidant when added to bread dough, although it is not commonly used in this country. The scientists found that as much as 2,560 ppm ascorbic acid may be added without affecting loaf characteristics, and as little as 80 ppm is sufficient. Adding 10 ppm potassium bromate and 80 ppm of ascorbic acid, Mr. Shogren says, furnishes an optimum combination of oxidants for essentially all bake tests.

Alfalfa Safeguards Ground Water

PLANTING unused feedlots to alfalfa after they are abandoned will prevent nitrate pollution of ground water that otherwise may occur.

ARS microbiologists Gerald E. Schuman and Lloyd F. Elliott, Lincoln, Nebr., found that corn is less efficient than alfalfa in removing accumulated nitrogen from the soil of abandoned feedlots.

When feedlots are in use, Dr. Schuman explains, nitrogen builds up mainly in the top 5 to 6 feet of soil in a relatively immobile organic form, but is unlikely to pollute ground water. When feedlots are abandoned, organic nitrogen may be converted to the nitrate form that moves down through the soil with moisture once the relatively impenetrable surface seal breaks down.

At the start of the study, the microbiologists found 13.5 tons of total nitrogen per acre in the soil cores to the 10-foot depth in a recently abandoned feedlot. This nitrogen, concentrated at and near the soil surface and readily convertible to nitrate, could have polluted ground water if not removed by cropping, the scientists say.

In the 3-year test, alfalfa removed 98, 394, and 528 pounds of soluble nitrogen per acre from the soil, without excess accumulation of nitrate in alfalfa forage.

Corn took up 152, 265, and 81 pounds of nitrogen per acre, Dr. Schuman reports. Nitrogen removal by corn was low the third year when drouth caused near crop failure.

Nitrogen levels were above safe limits in corn stover, which would have had to be diluted with other feed if given to livestock. Dr. Schuman says the corn also lodged because of the high nitrogen levels in abandoned feedlot soil.

The Nebraska Agricultural Experiment Station cooperated in the study.

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AGRISEARCH NOTES

Sugar Blocks Extend Season

IN MANY AREAS of the world, raw cane sugar factories are operated on a seasonal basis. Plants close after the harvest is processed. This highly inefficient mode of operation leaves the factory standing idle until the next harvest.

All this may change as a result of pilot plant studies conducted by ARS chemist B. Ashby Smith. Mr. Smith and his associates, working at the Food Crops Utilization Research Laboratory, Weslaco, Tex., have determined that crude, raw sugar blocks which are produced in rural areas of many tropical countries could help extend the production season of conventional cane sugar plants.

The crude raw sugar is known as "panela," "papelon," "chancaca," "raspadura," "jaggery," "gur," "moscovodo," or "piloncillo"—depending on the country where it is produced. Methods used to make the blocks vary according to local preferences, labor, and availability of equipment.

The harvested cane is stripped by hand, and the juices are extracted by passing the stalks through a small mill. Lime, bark of local trees, or other material are occasionally used as clarifying agents for the juices. The juices are heated and concentrated in an open kettle, while they are being skimmed. Once the desired consistency is reached, the juices are discharged into molds. Hard blocks of sugar are formed on cooling. The blocks consist of sucrose crystals cemented with molasses. They can be stored for long periods.

The blocks are then crushed, melted, and made into sirup. Next, an evaluation is made of the extent of processing required for pilot plant production of centrifugal raw sugar, and of the quality of the crystalline sugar so produced. According to Mr. Smith, sirups made from melted Mexican "piloncillo" sugar cones required no processing or clarification, except for settling of insoluble matter before sugar boiling. In all tests raw crystalline sugars of satisfactory quality were produced.

These findings are a boon to sugarcane growing areas of this country, and of developing countries in Asia, Central America and South America, and equatorial Africa. Local hard sugar block producers can supply sugar plants with blocks once their cane supply is exhausted. Off-season production is enhanced because the blocks can be stored without a loss in quality.

Everyone benefits. The conventional mill extends its season of operation beyond the production of the regular cane harvest. The small farmer and producer of sugar blocks gain increased job opportunities and earn income where such opportunities are often scarce. And those with a sweet tooth know that their source of supply flows undiminished.

When reporting research involving pesticides, this magazine does not imply that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if not handled or applied properly. Use all pesticides selectively and carefully.

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